

with the fauna of other parts of the state of Tennessee is remarkable. The number of forms is surprisingly small, and yet there is a high percentage of shells, which are peculiar to the Mississippi Embayment. This fact should be kept in mind, for it is important in the study of the development of the Naiad faunas of North America.

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THE ACANTHODORIDIDAE OF THE CALIFORNIA COAST

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BY F. M. MAC FARLAND

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(Concluded from page 65)

ACANTHODORIS COLUMBINA sp. nov. Plate II, Figures 5, 9, 10, 11; Plate III, Figures 1, 2, 5.

Six individuals of this form were collected at low tide in reef pools at Moss Beach, near Montara Point, San Mateo County, California, on July 26, 1922. A second collecting trip to the same locality on May 3, 1923, failed in securing any more of this interesting new species.

The animal has the plump, nearly oval outline characteristic of the Acanthodorids. The foot is completely covered by the wide, thick border of the mantle, save for the tip of the tail. The dorsum is covered everywhere with closely-set, slender, tapering papillae, reaching 1.5 to 2.0 mm. in length, and giving it a soft, velvety appearance. This is rather deceptive, however, for the body is firm to the touch, the mantle being everywhere filled with slightly curved calcareous spicules (Pl. III, fig. 2) interlacing in various directions. Each papilla is reinforced by a group of spicules, mainly lengthwise in arrangement, and nearly filling it. These extend well down into the dorsum, and are strengthened by others added at lower levels, so that each papilla contains a firm, skeletal framework, precluding anything more than slight movement of its apical half. The margins of the rhinophore openings are similarly reinforced.

The ground color of the dorsum is a dusky, brownish mauve. The papillae are tipped with lemon yellow, and each one is more or less deeply shaded with brown, and none of them are

white. The stalks of the rhinophores are brownish sprinkled with small, lemon-yellow spots, similar ones being also found between and on the plates of the clavus, which is otherwise of a deep, vinous-red color, as are also the tips of the branchiae. The upper margins of the main stalks of the plumes and the beginnings of their main branches bear a row of small, dead white, rounded nodules. A narrow, continuous band of lemon yellow edges the ventral margin of the mantle in all six specimens. The ventral surface is much paler, everywhere tending toward a yellowish grey. In alcohol the yellowish marginal line disappears, but the other colors, though lighter, are preserved for some time.

The largest specimen measured, while living and crawling freely, 32 mm. in length, 15 mm. in width, and 9.0 mm. in height, the others being but slightly smaller.

The head is of the usual shape, wide and expanded in a veliform manner, and produced at the lateral angles into widely triangular, or even squarish tentacles, directed backward. The foot margin is single in front, and bluntly tapering behind, extending but slightly beyond the mantle when crawling.

The rhinophores are directed outward and forward, are perfoliate with from 22 to 26 leaves, and are surrounded by low, thin-edged sheaths into which they are incompletely retractile. The sheath margins bear a small, variable number (six to ten) of longer and shorter processes, resembling those of the general dorsum.

The branchial plumes are nine in number, low, spreading, and bipinnate, and are arranged in a circle surrounding the anal papilla, the area bearing numerous low papillae, similar in form and color to those of the general dorsal surface. The spicules (Pl. III, fig. 2) are slender structures, pointed at both ends and slightly bent as a rule. The largest measured 0.9 mm. in length, though the average length is considerably less. No traces of branching were found.

The pseudo-peritoneum is sparingly sprinkled with minute black dots, mainly in the anterior region. The thick-walled muscular ingluvies is borne upon the anterior, upper face of the pharyngeal bulb as a low, hemispherical projection, 1.5 mm.

in length. 1 mm. in height, and 1.75 mm. wide. Its median line is sharply marked by a longitudinal band of muscle, forming the bottom of a shallow groove between the two symmetrical halves. Behind the radula sack projects freely for a distance of 1.2 mm. Immediately behind the ingluvies the oesophagus issues, surrounded by the nerve collar, bearing just in front of the latter a well marked, dilated sack-like portion, ca. 2.0 mm. in diameter. The salivary glands open into the bulb at either side of the exit of the oesophagus. They are long, strap-like organs (Pl. III, fig. 5), the short, slender duct (*d*) being followed by a thickened, somewhat lobulate portion, which is in turn followed by a more slender division, terminating near the entrance of the oesophagus into the stomach. Their total length is ca. 5.8 mm., and the greatest diameter at the widest portion is 0.4 mm.

The labial disk, surrounding the slit-like mouth opening, bears an armature of minute, cuticular plates, interrupted below, and extending laterally nearly to the upper side of the opening, the area so covered being triangular in form, with the base ventro-posterior and the apex dorso-anterior. The elements of the armature (Pl. II, fig. 5) are blunt hooks, triangular in side view, ca. 0.009 mm. high, the length of the base being 0.012 mm. From above each hook is broadly rectangular in outline, the squarish cusp directed forward, 0.068 mm. in width, the margin being irregularly denticulate, or in some cases with a single median notch. The elements of each lateral area are arranged in from 30 to 35 rows, parallel to the long axis of the mouth tube; the longest rows in the widest part of the armature contain some 26 elements, the number decreasing toward the top of the tube, the lowermost rows, next to the median plate also having few and rudimentary hooks. The labial armature is interrupted below by a median, ventral cuticular plate, projecting freely beyond the opening of the oral disk. This structure (Pl. II, fig. 11) is 0.36 mm. long and 0.097 mm. wide at its broadest, posterior part. It is slightly concave on its upper surface, and is finely striated longitudinally, the striae gently diverging anteriorly. The anterior free end is bifurcated by a narrow notch or cleft, extending back in

the median line 0.09 mm., the two tips thus formed being irregularly blunted and worn.

The radula is of the typical, narrow, deeply folded form characteristic of the genus. The radula formula is 40-43 (5. 1. 0. 1. 5), the anterior teeth are colorless, the more posterior ones toward the tip of the radula sack, but not the youngest ones, take on a yellowish tint. The median tooth is absent, the rhachis being very narrow and naked, but the first lateral tooth (Pl. II, fig. 10) is quite large and strong. The large, compressed, basal portion is roughly quadrangular in lateral outline, its anterior and ventral margin being strongly thickened, the posterior part is prolonged backward as a thin lamina, which overlaps the anterior portion of the succeeding first pleural tooth of the next row. The upper posterior border is rounded. From the anterior, thickened portion of this base arises a stout hook, slightly curved backward. Its tip is blunt, the posterior margin is thin, while the anterior edge is thickened and is strengthened by a strong ridge on its inner face which dies away toward the tip, and bears a series of six to eight small, but well marked denticles, merging below into slight irregularities of the ridge margin. Figure 10 of Plate II represents the first laterals of one-half of the seventh and eighth rows as seen from the median side, and fig. 9 of the same plate shows the first laterals of the 28th and 29th rows as seen in front view. A comparison of these figures with similar ones on the same plate of the other species discussed in this paper, all drawn at the same magnification, will render evident many differences of detail, proportion, and relative size, which are here omitted for the sake of brevity. The total height of an average first lateral is 0.324 mm., the height of its hook being 0.096 mm., the proportion of height of hook to total height being nearly as 1 to 3.4, this proportion holding true within small limits throughout the whole radula. The remaining laterals, five in number (Plate II, fig. 10), are much compressed, and lie at about the level of the base of the hook of the first lateral in the functioning part of the radula. Each is a flattened plate, somewhat approximating the outline of the first. The second is especially thin, and is faintly seen behind the first

lateral, the remaining four have their antero-dorsal margins thickened, and prolonged upward and backward into a hook-like process, which, however, does not project freely, as in the first lateral, but is continuous ventrally and posteriorly with the thin, upward expansion of its base, the whole tooth being somewhat triangular in form.

The reproductive system is composed of the ovotestis, closely covering the most of the surface of the liver, the anterior genital complex, consisting of the large, white, nidamental gland, nearly inclosing the much smaller, yellowish, albumen gland, and of the various ducts of the system. Since the relations of these parts are of decided significance from a systematic as well as from a morphological standpoint, I give in Fig. 1 of Plate III an accurate camera drawing of the anterior complex as seen obliquely from above and within. No displacement of the ducts has been made other than is necessary to bring out their relationships, but connective tissue, nerves and blood vessels have been dissected away for the sake of clearness. The short and slender hermaphroditic duct (*h. d.*), coming from the ovotestis, dilates into the hermaphroditic ampulla (*h. a.*), a whitish tube, 0.8 mm. in diameter, forming a simple loop nearly 7.7 mm. long, resting in a shallow groove upon the inner anterior face of the albumen (*alb. g.*) and the nidamental (*n. g.*) glands. At its anterior end it narrows again and divides into the vas deferens (*pr.*) and the oviduct (*ov.*), the latter opening at once into the fertilization chamber, concealed in the gland complex at the border of the albumen gland.

The vas deferens is divisible into two distinct portions, a proximal segment (*pr.*), with glandular walls, 12.5 mm. in length, attached closely to the anterior and superior surfaces of the nidamental gland, and a slightly more slender, distal, muscular portion, 17.5 mm. in length, the loops of which are free from the glandular mass, extending in front and to the left of it beneath the oesophagus. In figure 1 of Plate III, the proximal, glandular, or prostatic portion (*pr.*) extends to the point indicated by *x*, and is here represented as partly straightened out, after having been freed from its close attachments to the anterior and upper faces of the gland complex, the loops between

*pr.* and *x* normally lying above the bifurcation of the hermaphroditic duct. The distal end of the vas deferens dilates into the preputium (*p.*) some 4.5 mm. in length, by 1.0 mm. in diameter, an eversible, muscular sack with longitudinally folded, inner lining of ciliated epithelium. At the bottom of this sack is found the very short and blunt glans penis, scarcely more than a rounded eminence. It appears to be entirely destitute of the armature of small hooks usually held to be characteristic of Acanthodorids in general, nor are any such hooks to be found lining the vas deferens. Throughout the muscular segment of the tube it is lined with ciliated epithelium, resting upon a strong basement membrane, in certain regions folded longitudinally. The total length of the male channel is 34.5 mm.

Close to the entrance of the short oviduct (*ov.*) into the gland complex the slender, uterine duct (*u. d.*) emerges. After a short course of ca. two mm., it receives the slender duct of the spermatocyst (*sp. c.*), and almost immediately opens into the spherical spermatheca (*sph.*). The spermatocyst is of an elongated, pyriform shape, 2.0 mm. in length by 1.0 mm. in greatest diameter, and lies obliquely upon the dorsal surface of the complex. The thin-walled spermatheca, 2.0 mm. in diameter, lies midway of the dorsal border of the anterior genital complex, partly concealed by the spermatocyst and the loops of the overlying vaginal duct. The latter duct (*vag. d.*) arises from the spermatheca very close to the entrance of the uterine duct, in fact appearing to be continuous with the latter. It rapidly increases in diameter, its walls becoming very glandular and longitudinally folded, and forms a complicated series of loops upon the upper, inner and anterior faces of the spermatheca, and then passes outward, dilating into the vagina (*vag.*), which opens externally immediately behind the preputium in the genital sinus. From the left turn of its most distal loop a rather strong retractor muscle extends diagonally inward and backward. The glandular and plicated walls of the tube are limited to the more closely coiled, proximal loops, the remainder and the vagina proper possessing muscular walls. The total length of the vaginal duct averages nearly 16 mm., the vagina itself is 4 mm. long, with a diameter of 0.6 mm.

In general ground color this species resembles *Ac. nanaimoensis* O'Donoghue, of the Vancouver region. Through the kindness of Professor O'Donoghue I have had the privilege of studying a fine specimen of the Vancouver form, and find that the two are clearly distinct species. While both agree in the general mauve color of the mantle, and in the port-wine shade of the branchial tips, the dorsal papillae are white or yellowish in *Ac. nanaimoensis*, while in *Ac. columbina* they are brownish, and tipped with lemon yellow. The Californian species also has the lower mantle margin edged with a narrow line of lemon yellow, and the rhinophores are sprinkled with small flecks of the same color. The following tabulation summarizes a number of other distinctive characteristics:

	<i>Acanthodoris nanaimoensis</i> O'D.	<i>Acanthodoris columbina</i>
Rhinophore leaves	28-30	22-26
Labial elements	In 70-80 rows	In 30-35 rows
Median plate of labial armature	0.66 mm. long by 0.225 mm. wide	0.36 mm. long by 0.097 mm. wide
Radula formula	35(6-7.1.0.1.6-7)	40-43(5.1.0.1.5)
Average height first lat.	0.525 mm.	0.324 mm.
Average height hook first lateral	0.226 mm.	0.096 mm.
Proportion of height hook to total height	1 : 2.3	1 : 3.4
Denticles 1st lateral	None	6-8

The further dissection showed numerous specific differences, especially in the details of the reproductive system, but the above summary will suffice alone to confirm their non-identity.

My grateful acknowledgements are due to Dr. Myrtle E. Johnson and Professor C. H. O'Donoghue for their kind cooperation, and especially to my wife for her unfailing skill and enthusiasm in the preparation of the figures, which illustrate this paper.

## EXPLANATION OF PLATES

## Plate II

- Fig. 1. *Acanthodoris hudsoni* MacF. Inner face first lateral teeth of 7th and 8th half rows of radula. In the 8th row the five outer laterals are also shown. x 128
- Fig. 2. Individual elements of labial armature of *Ac. lutea* sp. nov., from side and behind. x 371
- Fig. 3. Elements of labial armature of *Ac. rhodoceras* Cockerell and Eliot; *a*, from anterior margin in side view; *b*, from middle region from above; *c*, from posterior margin from above. x 371
- Fig. 4. Inner face of first lateral teeth of 7th and 8th half rows of radula of *Ac. rhodoceras* Cockerell & Eliot. In the 7th row the six outer laterals are also seen. x 128
- Fig. 5. Labial armature of *Ac. columbina* sp. nov., the two upper elements from above, the two lower ones from behind and in side view respectively. x 371
- Fig. 6. Ventral median plate of labial armature of *Ac. lutea* sp. nov. x 83
- Fig. 7. Inner face of first lateral teeth of 7th and 8th half rows of radula of *Ac. brunnea* MacF. In the eighth row the outer laterals are also seen. x 128
- Fig. 8. Inner face of first lateral teeth of 7th and 8th half rows of radula of *Ac. lutea* sp. nov. In the eighth row the outer laterals are also seen. x 128
- Fig. 9. Front view of first lateral teeth of 28th and 29th half rows of radula of *Ac. columbina* sp. nov. x 128
- Fig. 10. Inner face of first lateral teeth of 7th and 8th half rows of radula of *Ac. columbina* sp. nov. In the eighth row the five outer laterals are also seen. x 128
- Fig. 11. Ventral median plate of labial armature of *Ac. columbina* sp. nov. x 128



## Plate III

Fig. 1. Anterior genital complex of *Acanthodoris columbina* sp. nov., as seen from above. The various parts are displaced only enough to show their relations. The glandular loops, *pr.* to *x*, of the vas deferens, *v. d.*, have been freed from their attachments to the upper, anterior face of the complex, and are rotated to the left and forward; the loops of the vaginal duct have been similarly displaced to the right from their normal position above the spermatheca and its ducts. x 10

*h. d.*, hermaphroditic duct; *h. a.*, hermaphroditic ampulla; *pr.*, prostatic portion of vas deferens, *v. d.*, extending to the point *x*; *p.*, the preputium; *ov.*, the short oviduct, entering the fertilization chamber in the gland mass below; *vag.*, the vagina, tapering into the vaginal duct, the last, crescentic loop, *vag. d.*, of which is thickened and glandular; *spth.*, the spermatheca; *u. d.*, the uterine duct, connecting the spermatheca with the fertilization chamber; *spc.*, the spermatocyst; *alb. g.*, the small albumen gland, surrounded by the nidamental gland, *n. g.*, the duct of which, leading to the exterior, is concealed by the preputium and vagina.

Fig. 2. Typical spicules from mantle of *Ac. columbina* sp. nov. x 26

Fig. 3. Typical spicules from mantle of *Ac. lutea* sp. nov. x 45

Fig. 4. Female channel of *Ac. rhodoceras* Cockerell & Eliot. *vag.*, the vagina; *v.*, the spherical, glandular vesicle; *vag. d.*, the vaginal duct; *spc.*, the spermatocyst; *spth.*, the spermatheca; *u. d.*, the uterine duct, leading to the fertilization chamber. x 12

Fig. 5. Salivary gland of *Ac. columbina* sp. nov., *d.*, its duct. x 10

Fig. 6. Anterior genital complex of *Ac. lutea* sp. nov., as seen from above, the various parts being displaced as

little as possible. The attached loops of the vas deferens, *v. d.*, have been freed from their close union to the complex and spread apart toward the left, the loop *x* normally lying against the anterior face of the mass. The loop of the vaginal duct below *vag.*, is reflected backward from its normal position across the distal part of the preputium, *p.*, and its proximal thin loop at the left is normally directed straight backward, the thicker, glandular loop *gl* overlying and concealing the ducts of the spermatheca and spermatocyst. x 8

*h. d.*, hermaphroditic duct; *h. a.*, hermaphroditic ampulla; *pr.*, prostatic portion of vas deferens, extending to the point *x*, and closely bound down to the antero-dorsal surface of the complex by connective tissue; *v. d.*, the free, muscular loops of the vas deferens, extending below the oesophagus; *p.*, the preputium, the glans penis, *g.*, being represented as if seen through its muscular wall; *vag.*, the vagina, tapering insensibly into the vaginal duct, which dilates into a short glandular segment, *gl.*, before entering the spermatheca, *spth.*; *spc.*, the spermatocyst; *u. d.*, the uterine duct, entering the fertilization chamber near the entrance of the oviduct, *ov.*; *n. g.*, nidamental-albumen gland complex, its broad duct leading to the exterior below the preputium and vagina.

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#### NOTES AND NEWS

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MOLLUSCA OF THE AREQUIPA VALLEY, PERU.—The Arequipa Valley, outside of the irrigated areas, is excessively arid, and I was not able to find any native mollusca. I could not even find ants in the desert. In a damp place by the railway at Tingo, where the common dandelion was growing, I found *Agriolimax agrestis* and an immature brownish *Milax gagates*. Dr. E. Escomel gave me specimens of *Polita cellaria* which he